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UMFC #66 A Comprehensive Case Report

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UMFC #66

A COMPREHENSIVE FORENSIC ANALYSIS

CASE REPORT

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UMFC #66: A Comprehensive Case Report

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University of Montana Forensic Case #66 has been used as a teaching tool for many years. Little written information is available on the origin of this case. Information on the date of recovery is not available, nor are the circumstances surrounding the recovery.

My goal in this report is to understand more about this case, particularly age at death, ancestry, and pathology. This case is particularly intriguing because it presents a textbook example of osteomyelitis, a pathological condition. Additionally, it is of significance to the history of the area because of its recovery in the state of Montana. As a current graduate student in the University of Montana Forensic Anthropology Department, I have the great opportunity to examine this case. This paper presents the results of a detailed comprehensive analysis incorporating current methods to further the knowledge concerning UMFC #66.

Since the time of discovery there has been speculation on the ancestry of this case. In some previous analyses the ancestry has been ascribed to the peoples of Africa, and in others to the peoples of Asia or the Americas. Based my interpretation of the data collected, I conclude that this person was of Native American descent. I estimate this person's age at between of 37 and 53 at the time of death. Osteomyelitis has greatly affected the left femur and adjacent bones. This caused a skeletal deformation of the ribs, possibly associated with lying on the side for extended periods of time. Cause of death can only be attributed to osteomyelitis since there is no other pathology or trauma indicating otherwise.

Acknowledgments

This is a milestone in my academic career and many people need to be recognized for their role in my education. Without the environment of hands-on learning, patience, and letting a little boy collect cattle bones from the pasture provided by my family, the foundation for my academic achievement would be lost. A huge thanks goes to my loving wife for inspiring me to pursue my dreams, helping when she could, and understanding the stresses of school. Thank you, Randy Skelton for the most amazing educational experience that will not end after graduation.

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Introduction

Forensic anthropologists consider one of their most important tasks to be a narrator for people who cannot tell stories for themselves. Law enforcement and families of victims look to forensic anthropology for answers to questions such as the person's identity as well as the timing and nature of their death. Answering these important questions using reliable anthropological methods brings about a feeling of accomplishment and perhaps writes the final chapter in a story often untold without the processes of forensic anthropology.

University of Montana Forensic Collection Case #66 is arguably the most intriguing case held by The University of Montana Anthropology Department. Pathology and ancestry are the two topics that make this case one of the most discussed in the Physical Anthropology laboratory. Through the course of study it becomes apparent that this case is a textbook example of a pathological disorder called osteomyelitis. Also, the ancestry of UMFC #66 has been under contention. Ancestry has been described as Native American, Asian, African, and multiple combinations among these categories. Because of the evidence of osteomyelitis as well as the ancestry controversy, UMFC #66 is an interesting subject for a comprehensive case report.

Much can be gained from a comprehensive case report on UMFC #66 in terms of demonstrating the methodology of forensic anthropology. This case utilizes a multifactoral approach to attain a more complete analysis of the individual. For example, the multifactoral approach helps the precision of determining age when ancestry is also known. Through a variety of methods, a complete analysis of case UMFC #66 will be presented.

Literature Review

Age Estimation from Ectocranial Suture Closure

The understanding that there is a relationship between age and the appearance of the cranial sutures, the joints between the bones of the cranium, is ancient. Hippocrates, Aristotle, and Galen were acquainted with the fact that some human crania show a multiplicity of sutures whereas others are almost or totally devoid of sutures (Todd and Lyon, 1924). This realization was the springboard for future attempts in using the cranium as an indicator of age.

In the sixteenth and seventeenth centuries cranial suture closure was still enigmatic to the medical community. During this period suture closure was correlated to race and intellectuality. Todd and Lyon (1924) gave the example of Gratiolet, who in 1865, ascribed the open sutures of an intellectual White male to a youthful personality. This correlation attempted to link open sutures to a higher intellect by suggesting that they enhanced the ability of the brain to grow. According to this theory, the "lower intellect" races had cranial sutures that closed earlier in life, thereby stopping the brain's growth. In these people suture closure essentially held the brain in "prison," to remain unchanged throughout life, as well as acting as a helmet capable of resisting blows. These early attempts to understand cranial suture closure were strongly linked to the ulterior motives and personal agendas of the researchers. Hence, they did not contribute to the advancement of techniques for estimation of age.

It was known even in these early times that throughout life the sutures change from being open (unfused - the suture visible as a distinct crack along its entire length) to near non-existent (fused - the suture obliterated due to fusion with neighboring bones) late in life (White and Folkens, 2000). As seen in Parson and Box (1905), there is a significant difference between the methodology presented in earlier studies and the more scientific approach used today.

Todd and Lyon (1924, 1925), also published articles describing changes in the cranial vault sutures relating to age. Their methods were viewed as flawed by a portion of their contemporaries because anomalous individuals were removed from the sample group. Some see the removal of 40 individuals from 307 “white” skulls and 41 individuals from 120 “black” skulls in Todd and Lyon’s data set as a way to skew the results to fit the desired framework of age estimation (Krogman and Iscan, 1986). However, Krogman and Iscan (1986) argue that there is no reason to believe that removing extremes (anomalous crania) from either end of the range unduly influences the central tendency.

Todd and Lyon’s (1924, 1925) methods resulted in a high degree of variability in characteristics of the suture of different individuals when compared to the known age, giving exceedingly inaccurate age estimation results (Byers 2002). Todd and Lyon (1924) stated that “it cannot be denied that so far our work does not justify the uncontrolled use of suture closure in estimation of age.” With this statement, their research actually reduced the value of cranial suture closure as a method for age estimation of the individual (Krogman Iscan, 1986).

Since the time of Todd and Lyon, research on cranial suture age estimation methods has focused on attempting to reduce the high degree of variability in the Todd and Lyon method, with little success. Krogman and Iscan (1986) relate that McKern and Stewart noted in 1957 that there is only a general relationship between the progress of suture closure and age, and that suture closure should only be used as supportive evidence for other methods. Other methods developed during this era used the age found using cranial sutures along with methods such as dental attrition to attain more precise age estimates.

Meindl and Lovejoy (1985) re-examined the potential of cranial suture age estimation as they state in their article *Ectocranial Suture Closure: A Revised Method for the Determination of Skeletal Age at Death Based on Lateral-Anterior Sutures* (1985), the method was effectively abandoned during the mid-twentieth century as skeletal biology looked for one or two highly reliable age indicators. Also during this period, endocranial sutures were thought to be a better estimator for age because of their tendency to close earlier. This revised method is based on several previous studies, particularly Todd and Lyon's (1924 and 1925) work using 236 crania from the Hamann-Todd Collection.

Meindl and Lovejoy (1985) note that there is no study observing when and how cranial sutures close. It would be nearly impossible to observe the cranial suture closure of a particular individual through life.

Meindl and Lovejoy's revised method caused others to start using this characteristic again. Interest in the methodology presented in previous studies has sparked resurgence in cranial suture age estimation. White and Folkens (2000) present the 1985 version of Meindl and Lovejoy's method, as well as descriptions of various other authors' versions.

Revisions have been made to this method by many different skeletal researchers. Some are based on a composite scoring system; some have a more elaborate scoring system, or more suture sites are used with the intention of obtaining a more accurate age estimate (White and Folkens, 2000). Krogman and Iscan (1986) use only the sphenooccipital synchondrosis because at least 95% of all individuals have fusion here between 20 and 25 years of age. Perizonius (1984) completed a study with the same criteria as Todd and Lyon (1924 and 1925) arriving at the same results. Krogman and Iscan (1986) show in the first section of their discussion about determining of skeletal age from the cranium that modifications of the approach are all too common. Redfield studied the immature occipital bone sutures in 1970 with the focus on development. Weaver (1979) uses a six - stage sequence observing morphological changes in the temporal bone and tympanic ring. Stewart (1954) modified Cobb's (1952) version to a four - point total scoring system with nine suture sites. Revision of methods is common, and typically makes the method more appropriate for use in specific circumstances. The Meindl and Lovejoy method can be adapted further to case studies where fragmentary crania are examined, because the results of age estimates from individual sutures can be used, or averaged to gain a mean suture age of the individual at the time of death.

The key to the acceptability of a method for age estimation is its ability to give accurate and precise results upon repeated applications. Meindl and Lovejoy (1985) employ a simple four - point scoring system for a suture site. Areas of one centimeter in diameter around each suture site are used; areas outside the site that are differing are disregarded. This meticulous attention to methodology illustrates how interobserver replicability is improved by exact protocol. Until recently, this method of aging has been viewed as having excessively variable results regardless of sex or ancestry (Schwartz 1995).

One major shortcoming of this method is that it does not take sex and ancestry into account. Cranial sutures have a varying degree of complexity among different ancestral lineages. This has not been studied extensively, but there is a possible correlation between closure rates and the complexity of the suture (Todd and Lyon, 1924 and 1925). However, if the method was revised to account for sex and ancestry, it likely would become overly complicated, thereby losing applicability. Another shortcoming is that it is less accurate for younger individuals.

Age estimation from cranial sutures is important for Case UMFC #66 because the case exhibits osteomyelitis, which has caused pathological changes that affect the accuracy of those age estimation methods based on the pelvis, vertebrae, and ribs. The dentition is also fragmentary with much occlusal wear, inhibiting accurate age estimation. Ectocranial suture closure for this case seems the most reliable method for age estimation.

Background and Materials

This case is from the University of Montana Forensic Collection. The remains have been housed in the physical anthropology laboratory in a box labeled UMFC #66. No method performed in this study damaged or altered the remains. All results of methods performed are discussed in the following report.

UMFC #66 has little written information on record. The remains were recovered years ago, in connection with a law enforcement investigation. At that time, the Forensic Anthropology Laboratory did not keep provenience records, since this was considered the prerogative and responsibility of the County Coroner. At times in the past, however, systematic recording of case numbers was not done and the jurisdiction with authority over the case can not be determined at this time. Therefore, no information exists on the time of recovery, or the exact area where the remains were recovered.

Age

Methods for determining age typically fall into two categories. One pertains to developmental changes in the skeleton. Such developmental changes can be seen in the closure and fusion of the epiphyses, dental eruption and development, and long bone lengths, among others. Other types of change are degenerative in nature. These would include, but are not limited to, vertebral osteophytosis, changes in the pubic symphysis and auricular surface, and sternal rib ends. Understandably, not all methods will be appropriate for every individual. Degenerative age determination methods will not yield precise results for subadults and the same can be said for the adult skeleton if utilizing developmental methods for age determination.

Several aspects of the skeleton are diagnostic for age determination. Through experience with age estimation methods, the forensic anthropologist creates a mental framework of characteristics seen on a particular bone at a particular age. The utilization of this experience yields an understanding of the protocol for several age estimation methods, and a greater understanding of the individual's age at death is gained (White and Folkens, 2000).

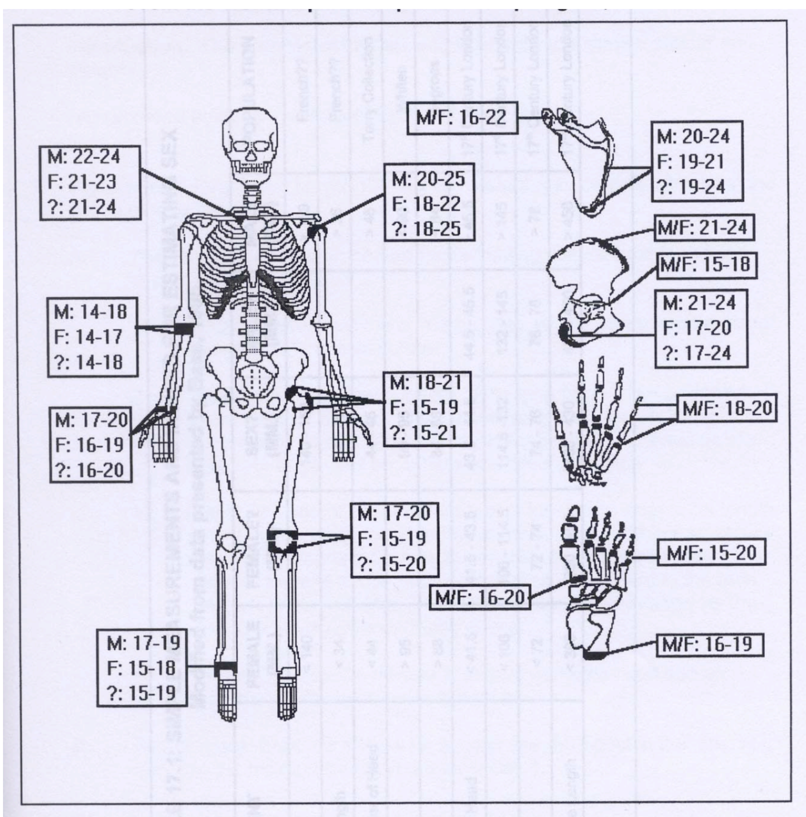
Precise age estimations cannot be made without knowing sex and ancestry. Knowing the sex and ancestry is essential for the precise association of the particular case to the proper method containing the proper sample group. The individual in case UMFC #66 is male and of Native American descent, as will be discussed later. Some methods for age estimation use sample groups aside from Native Americans because the skeleton exhibits considerable damage from years of handling and osteomyelitis.

Certain methods for age estimation will be discussed, but not applied to UMFC #66, due to the presence of osteomyelitis. Destructive pathological conditions impair accurate assessment and measurement of remains. Methods that will not be discussed at length are age determination methods for subadults.

Epiphysis Closure

In this case all epiphyses are closed and fused. According to Bass (2005) and seen in Figure 1.1 all epiphyses will be fused by the age of 24. At this point, age estimation is a minimum of 24 years old at death.

Figure1.1 Epiphysis Closure



(Skelton. 2006: 40)

Vertebral Osteophytosis

There is a dual reason for not using vertebral osteophyte development. First, the vertebral column is artificially articulated with green sculpting clay and epoxy. Second, osteomyelitis seen throughout the lumbar and thoracic vertebra could lead to erroneous age estimation for this individual (White and Folkens, 2000)

There is slight lipping of the vertebral body and incomplete fusion of the 4^{th} and 5^{th} lumbar vertebrae. Both are associated with the destructive nature of osteomyelitis and the degenerative processes of aging. Macroporosity is more evident on the left side of the vertebral body showing localized pathology. This inhibits an accurate estimation of age from osteophyte development.

Age from Sternal Rib Ends

However, from years of handling, some ribs are damaged. Through the method presented in Bass (2005) and Iscan (1984), age estimations can be made. The 4^{th} sternal rib end in particular shows damage from handling, hence the protocol required for estimating age from this method, was modified for this case.

Iscan's (1984) method has a graduated scale of 27 different categories for classification. Iscan provides descriptions and photos of the categories and the sub-categories for help in estimating age. Instead of only using the damaged fourth rib, the sternal end of ribs 2 through 6 were used for the age estimation of this case. This created a larger sample size, thereby achieving a more accurate age estimate.

Classification of the sternal rib ends into a single category was not possible. UMFC #66 exhibits characteristics of stage 5b to 6b, with an age range of 34.4 to 42.3 for phase 5, and 44.3 to 55.7 for phase 6, resulting in an age range of 34.4 to 55.7 for individual UMFC #66. Stage 5 (a,b,and c) is characterized by the rib-end cavity being moderately U shaped, having thinning walls, increased irregularity and sharpening of the rim, and some signs of deterioration and porosity. Phase 6 (a and b) is characterized by a noticeably deeper pit, with a wide U – shape. The walls are thin with bony projections, and the bone is noticeably lighter, with increased porosity. Classifying this individual into categories 5b to 6b increases the age range to 21.3 years. Increasing the age range will diminish the precision of this method but increase the probability the correct age is within the range described.

Age from the Pubic Symphysis

As seen in Bass (2005), the os coxa is one of the most important bones for age estimation. Typically, the os coxa is a bone that is regularly recovered and from it much knowledge can be gained. The auricular surface and pubic symphysis are the areas discussed by Bass (2005) for age estimation of adults. The pubic symphysis, where the left and right pubic bones meet anteriorly will show distinct changes from subadult to adulthood. A key attribute favoring the pubic symphysis for age estimation is the consistency of change between individuals.

A problem for this case again is the presence of osteomyelitis. In the case of UMFC #66, the os coxa expresses the destructive effects and anatomical distortion associated with osteomyelitis. The left os coxa is severely affected throughout by the infection, while its presence in the right effects to the right are localized to the pubic symphysis and the body of the Ilium among and posterior to the border of the auricular surface.

Osteomyelitis expressed in the os coxa has to some degree destroyed both sides of the pubic symphysis. Destruction of the pubic symphysis obviously impairs the ability to conduct this method of age estimation. The pubic symphysis on the left os coxa is all but completely destroyed. The symphysis on the right os coxa is damaged but not destroyed. However, none of the descriptions provided by Iscan (1984) match the characteristics seen on the right pubic symphysis. Moreover, the nature of the pubic symphysis being the joining point of both os coxae bones causes concern regarding the deformation due to the osteomyelitic infection. Unfortunately, an age estimate cannot be made with any confidence due to the pathological condition.

Age from Dental Attrition

Mastication is the facilitator of occlusal wear, which occurs when grit or dirt in the diet is chewed. Older individuals exhibit more occlusal wear, referred to as "dental attrition," and age is estimable from the amount of attrition. The diet of an individual generally changes little through life. Therefore, the rate of wear will be constant and regular with expected degrees of attrition accumulating throughout a lifetime. As Bass (2005) states, age at death can be determined if the rate of attrition is known. Dental attrition of modern American populations occurs slowly due to the presence of few abrasive materials in the diet, whereas aboriginal American Indians had rates of dental attrition that were quite rapid in comparison.

-Brothwell's 1965 Age Determination Method

This method for age determination is derived from Brothwell's 1965 model. The sample Brothwell used was premedieval British skulls. Age at death was determined independently and compared to occlusal wear of the three molars. Since UMFC #66 is likely a Native American male, this is not the group the skeleton belongs to, however this method presents a good starting point for age estimation. The destruction of other skeletal aspects requires alternate methods of age estimation, even if the sample group does not exactly match the estimated ancestry or diet of this particular individual.

Age estimation for UMFC #66 is seen in Table 1.1 below. The age range was calculated using the protocol provided by Brothwell (1965). After the age range for each tooth was calculated, an age estimate using all teeth represented was completed. The age estimation of 34.4 years is an average of means for all the respective teeth. The amount of deviation was calculated using the estimates for the individual teeth giving a 10-year age range.

Table 1.1 UMFC #66 Occlusal Wear Age Estimation

Upper	**Age Range**
LM1	35-45
LM2	25-35
LM3	Missing
RM1	25-35
RM2	35-45
RM3	Missing
Lower	
LM1	25-35
LM2	35-45
LM3	25-35
RM1	Missing
RM2	35-45
RM3	25-35

This gives a Mean age of 34.44 yrs + or - 5 yrs

Dental wear on this individual is extensive, indicating a diet containing substantial amounts of grit. Other factors that increase the occlusal wear of this individual include the edge-on-edge bite, and the temporal mastoid joint exhibits a large amount of lateral movement which can be associated with grinding of the teeth.

From the teeth present, dentin is only exposed in small pits on the occlusal surface. The upper and lower first molar on the left side do have a lot of dentin exposed not associated with periodontal disease or occlusal wear. Trauma or specific activities using the teeth as a tool might be responsible for this anomaly.

Several teeth are missing, including some missing premortem and some missing postmortem. The missing upper third molars show depressions in the alveolar margin indicating these teeth were congenitally missing. It is not uncommon for the third molars to never develop. As seen in Table 1.2, development of the third molar can be dependent on an individual's ancestral affiliation. Lack of the third molar can be as high as 70.6% in Carabis Indian Populations (Bass, 2005).

Table 1.2

Percentage Distribution of Missing Third Molars among Select Populations[a]

Group	Author		Number of jaws	Percent lacking one or more M_3
Chinese	Hellman	1928	19	32.0
Chinese	Knap[b]	1937	64	31.2
Mongols (Buriat)	Hellman	1928	21	17.0
Japanese	Hamano[b]		1300	18.4
Eskimo	Hellman	1928	55	13.0
Angmagssalik Eskimo	Pedersen	1949	257	26.7
East Greenland Eskimo skulls	Pedersen	1949	81	23.5
Modern unmixed S. W. Greenland Eskimo	Pedersen	1949	210	18.6
Modern mixed S. W. Greenland Eskimo	Pedersen and Hinsch	1940	319	11.0
Labrador Eskimo	Dahlberg	1949	23	16.0
Northwest Eskimo	Goldstein	1932	232	15.5
American Indian	Hellman	1928	55	13.0
Blackfoot Indian	Dahlberg	1949	25	8.0
Sioux Indian	Smith	1894	10	50.0
Early Texas Indian	Goldstein	1948	173	19.5
Carabis Indian	Maurel[b]		68	70.6
Hawaiian	Dahlberg	1945	25	24.0
Melanesian	Dahlberg	1945	165	4.0
Australian Aboriginal	Hellman	1928	20	13.0
West African Negro	Hellman	1940	?	2.6
American Negro	Hellman	1928	119	11.0
European white	Hellman	1928	61	20.0
White (Hungary)	Hellman	1928	?	49.0
American white	Banks	1934	461	19.7

[a]After Dahlberg (1951:Table 34).
[b]Cited in Pedersen (1949).

(Bass 2005:289)

Lovejoy Modal Tooth Wear Patterns

This method of dental attrition uses a sample from the prehistoric Libben skeletal population, a Midwestern United States sample group (White and Folkens, 2000). This is likely to be a closer sample group to UMFC #66 than that of the Brothwell sample group.

Brothwell, Bass, and Lovejoy noted that the wear of the occlusal surface is regular, constant, and a good indicator of age at death.

This method uses both mandibular and maxillary dentition. Mandibular and maxillary dentition for UMFC #66 is characterized by stage H. However, this stage has different age ranges for the maxilla and mandible. Stage H is marked by slight wear on the mandibular third molar, which can be seen on the corresponding tooth on the right side of the mandible. Exposed dentin is characteristic for this stage in the second molar, and can be seen on the left side of this molar. Lastly, the lateral incisors have fully exposed dentin and no enamel "ring," which is a characteristic presented by Lovejoy (1985).

Maxillary dentition age estimation can only be accomplished using the canines, one first premolar, and the first and second molars of both sides. The first molars have a moderate amount of exposed dentin, expressed only on the right side. The left side has much more exposed dentin and chipped enamel on the buccal and lingual aspects, which is associated with wear and years of post-mortem handling.

Stage H for the age estimation of the maxillary dentition gives an age range of 35-40 and while mandibular dentition gives an age range is 40-50 years. This creates a mean age of 42.5, with a standard error of 7.5 years.

Age from Dental Development and Eruption

According to Bass (2005), dental development is one of the most accurate indicators of chronological age. There are limitations for this age estimation method;

however, Ubelaker's (1978 as seen in Bass 2005) method is restricted to age estimations for individuals under 31 years old. Ubelaker used American Indians as the sample group in his research which corresponds to the individual in case UMFC #66. This individual has complete dental eruption, aside from the third upper molars. The mandibular dentition is fully developed with the third molars. Mandibular dentition was the focus of this method for this particular case, if not to define the age range at least to solidify the conclusion that the individual is of mature adult age.

The dentition is consistent with 35 or more years of age at death. A more specific age estimation could not be made because the completion of dental development imposes an upper age limit to the applicability of this method. This reinforces the other age estimations and confirms this particular individual is not in a developmental stage.

Age from Cranial Suture Closure

As presented in the first part of this report, cranial suture closure is an age estimation method that has had a long and controversial history. Until recently it has not been a particularly popular method. Researchers found this method unreliable because the variability of sutures to age. This method will yield an accurate result only for adult individuals, typically those over the age of 30 at death, other methods for suture closure age estimation are designed for subadults.

Resurgence of this method (Meindl and Lovejoy, 1985) has now brought an old technique back into the forensic anthropologist's arsenal, and by doing so it also adds another strategy for obtaining a more precise age range.

The cranial suture closure method, as presented in White and Folkens (2000) involves scoring the degree of suture closure at seventeen points on the skull. Fourteen ectocranial and three endocranial suture sites are utilized. Each site is assigned a score ranging from 0 – 3, and a composite score is calculated to assign the individual to a corresponding age range. The score of 0 – 3 correlates to the amount of closure. Sutures receiving a site score of 0 are open with no indication of closure. A score of 1 equates to the suture exhibiting minimal closure. Significant closure is scored 2, and complete fusion, also known as obliteration (no evidence of cranial suture at the site), is scored 3. Table 1.3 shows the score of each suture site.

In accordance with the methodology presented, scores for cranial sutures are as follows:

Table 1.3 UMFC #66 Age Estimation from Cranial Suture Closure

Suture Site	Score
Midlambda	2
Lambda	2
Obelion	2
Anterior Sagittal	2
Bregma	2
Midcoronal	3
Pterion	3
Sphenofrontal	3
Inferior Sphenotemporal	1
Superior Sphenotemporal	2
Incisive	3
Anterior Median Palatine	2
Posterior Median Palatine	2
Transverse Palatine	3
Sagittal (Endo)	3
Left (Endo) Lambdoidal	3
Left Coronal (Endo)	3

Composite Score	Age	St. Dev.
1 - 7 = 16	48.8	10.5
6 - 10 = 12	56.2	8.5
Mean	52.5	

As seen above, two age ranges can be found using this method. Average age is calculated using both age means. The mean age of UMFC #66 is 52.5. The age range is the average of the standard deviation for both estimations. It can be posited using this method the individual does lie within this 19-year age range at the time of death.

Age from Auricular Surface

The auricular surface is the os coxal side of the joint between the os coxa and the sacrum. Age estimation from the auricular surface is based on morphological changes seen on the auricular surface. Osteomyelitis affected the os coxa bones of this individual. The left os coxa is deformed and is not suitable for application of this method. The right os coxa is less affected by this pathological disorder. Osteomyelitis is seen in close proximity to the auricular surface, and has changed the characteristics of this area.

Using the method of Lovejoy (1985), the auricular surface resembles a minimum phase 5 to early phase 7, from the 8 choices presented. The auricular surface exhibits characteristics from the three different phases mentioned. This surface is altered by osteomyelitis, causing a more broad classification in the phases. To make a confident estimation of age in an area of the skeleton affected by osteomyelitis it is necessary to create a more encompassing age range. By choosing this age range, the individual could be at a minimum of 40 years and a maximum of 59 years old at time of death.

Age Estimation Conclusions

Throughout this section of the comprehensive case analysis, osteomyelitis and years of handling made the estimation of age difficult. The primary difficulty of age estimation for this case lies in the destructive nature of osteomyelitis, which will be discussed at length in the pathology section.

Cranial suture closure is the method that most confidently estimates age for this particular case. Lack of osteomyelitis affecting the cranium makes for a more precise analysis. Years of handling have damaged components such as the sternal rib ends and specific aspects of the dentition. These factors make age estimation methods based on cranial suture closure more usefull.

Evidence obtained through these age estimation methods has provided a minimum and a maximum age. Through the course of age estimation all methods presented are used to provide an age range of 36.3 to 53.2. This multifactoral approach used all methods discussed excluding epiphysial closure (because the individual is not in a developmental phase) an average of the minimum and maximum ages was calculated to obtain this estimate. However, as discussed earlier the most confidence is placed on cranial suture closure methods that have a mean age of 52.5 showing the individual is closer to the maximum age when using the multifactoral approach.

Ancestry

Ancestry, or race, is a controversial topic of study. It is rare to find a topic that draws so much controversy among similarly educated professionals. Attempting to avert this heated battle, the term ancestry will be used in exchange for the outdated word race. The term ethnicity is inappropriate and defines culture rather than biology.

Throughout time there have been many attempts to define ancestry. Obviously there are still problems with the concept. However, describing a deceased individual in a manner useful for identification is awkward if the concept of ancestry is not used.

Ancestry from the Skull

The skull is the only region of the skeleton from which an accurate estimation of ancestral origin may be obtained (Bass, 2005). Visual assessment and metric analysis of the skull uses traits that define ancestral affiliation. Both use methods with specific protocol in the analysis of the skull to estimate ancestry.

Visual characteristics mentioned by Bass (2005) for Asians and American Indians are evident on the skull of this individual. Table 2.1 defines the characteristic of a trait in relationship to ancestry. UMFC #66 has projecting zygomatic bones, which is a characteristic for persons of Asian or American Indian ancestry. The nasal aperture is wider than what would be seen in peoples of European descent, and too narrow to be characteristic of peoples of Africa. The nasal bones project past their connection with the maxilla, representing an Asian or Native American trait. The edge-to-edge bite or lack of prognathism indicates this individual to be of Asian or Native American ancestry.

A retreating forehead angle is characteristic of peoples of African ancestry. The cranial sutures, particularly the lambdoidal suture, are complex, typical of Native American ancestry. The nasal spine is both moderate in size and projection, typical of American Indian ancestry. There is a moderate amount of nasal guttering, and moderately sized nasal aperture, typical of individuals of Asian or Native American descent. The skull is long and narrow, which is a trait of the peoples of Africa. The profile of the skull is low and sloping with a post-bregmatic depression, similar to that of peoples of Africa.

Table 2.1 Cranial Characteristics and Ancestry

TRAIT	"MONGOLOID" "	CAUCASOID"	"NEGROID"
Skull length	long to short	long to short	mostly long
Skull breadth	broad	narrow to broad	narrow
Skull height	medium	high	low
Coronal contourround		long to round	long
Sagittal contour	arched	round	flat
Frontal bossing	females only	females only	both sexes
Face breadth	broad	narrow	narrow
Face height	high	high to medium	low to medium
Face projection	not projecting	nose projects	jaws project
Zygomatics	weak back taper	strong back taper	strong back taper
Interorbital dist	medium	narrow	wide
Orbit shape	rounded	angular to round	rectangular
Nasal orifice width	medium	narrow (ht=2wd)	wide (ht=wd)
Nasal bones width	medium	narrow	wide
Nasal sill	sharp edge	smooth edge	sharp edge
Palate width	medium	narrow to medium	wide
Ruggedness	Medium	Gracile	Rugged

(Skelton 2006: 22)

Ancestry from the Sacrum

Deformation of the sacrum from osteomyelitis makes this particular method less reliable than others. An attempt to extract as much information as possible from the sacrum is used in this analysis. Osteomyelitis affects sex and ancestry estimation methods by the change of its curvature. Typically male characteristics show a more curved sacrum and coccyx, and females exhibit a flatter sacrum and coccyx (Bass. 2005). The sacrum of this individual is not as curved as expected when compared with the robust features of the cranium, suggesting that it is deformed from osteomyelitis. Therefore the sacral index, upon which ancestry estimation from the sacrum is based, will be equally distorted.

Sacral indices are a composite score of sacrum length and width (Bass 2005). The sacral index is the maximum anterior breadth multiplied by 100 then divided by the maximum anterior height. UMFC #66 has a sacral index of 100. Measurements were taken for anterior breadth and height, both equaling 109 millimeters. Three groups closest to the sacral index of this individual are the Australian Males, Japanese Males, and the Egyptian Females. This method does not limit UMFC #66 to only these populations described; instead this removes groups that are considerably farther from the sacral index of the individual. Table 2.2 outlines many groups with which this individual is possibly associated.

Table 2.2 Ancestry from Sacral Indices

Racial Indices of the Sacral Index (from Wilder 1920:118)

	Males	Females
Negroes	91.4 (33)	103.6 (18)
Egyptians	94.3 (7)	99.1 (2)
Andamanese	94.8 (22)	103.4 (35)
Australians	100.2 (14)	110.0 (13)
Japanese	101.5 (37)	107.1 (30)
Europeans	102.9 (63)	112.4 (43)

(Bass 2005: 109)

The sacral index probably does not give a clear estimation of ancestry in this case due to the extent of skeletal deformation caused by osteomyelitis.

Ancestry from the Scapula

Ancestry estimation from the scapula is a method for confirmation or refutation of ancestry associations made using other methods. The methodology is similar to the sacral index in that ancestral affiliation will likely encompass more than one appropriate ancestral group (Bass 2005). Theoretically, if a case was presented with only a scapula, a rough estimate of ancestry could be made.

Table 2.3 shows typical scapula measurements. The right scapular index is 56.3 and the left is 62.5. The formula for scapular index is maximum breadth multiplied by 100 then divided by the maximum length. Table 2.4 shows the index for the left scapula is applicable for assessment of ancestry and fits within the range of all male and female populations shown, and therefore is usable for assessment of ancestry. However, the right index is too small, and falls outside the range of scapular indices for known human populations. UMFC #66 has a left scapular index closest to that of Finn males, with a mean index of 62.4 a result at odds with other estimates of ancestry. Skeletal deformation, osteomyelitis, and asymmetry are possibly the cause for this anomalous result. Viewing the scapular index results more broadly it tends to confirm previous estimates the individual is not of African descent, since this ancestry tends to have larger indices, and given the cranial results, helps support the hypothesis that the individual is of Native American descent.

Table 2.3 Scapula Measurements

Scapula Measurements	Left	Right
Max Length	155	165
Max Breadth	97	93
Length of Spine	132	119
Supraspinious Line	47	55
Infraspinious Line Glenoid Length	122 37	127 37
Scapula Index	62.5	56.3

Table 2.4 Ancestry from Scapular Indices

Sample of Scapular Dimensions and Indices Arranged by Scapular Index[a]

	Male				Female			
Group	Number	Height total[b]	Breadth	Scapular index	Number	Height total	Breadth	Scapular index
Fuegian	35	16.02	9.90	61.8	28	14.33	9.22	64.3
Eskimo	4	15.70	9.72	61.9	4	(15.87)	(9.85)	62.0
Finn	72	16.55	10.25	62.4	14	14.80	9.32	63.9
New Caledonia	10	14.83	9.60	63.6	5	12.86	8.94	69.5
Europ. white	146	16.76	10.65	63.7	102	13.55	9.05	66.8
Old Peruv. Indian	55	15.83	10.17	64.2	39	13.78	9.17	66.5
Fuegian	7	15.38	9.88	64.3	2	14.20	9.40	66.1
N. W. Indian	10	16.52	10.48	64.3	14	14.07	9.37	66.1
Portuguese	37	15.92	10.21	64.4	20	13.62	9.04	66.5
Fuegian	4			64.8	6			65.7
French	78	15.92	10.37	65.2	68	14.11	9.28	65.9
U.S. white	70	16.40	10.70	65.3	44	14.40	9.60	66.7
Mex. Indian	9	15.80	10.40	65.5	12	13.75	9.75	70.7
Egyptian	6			65.9	9			68.0
Egyptian	11	15.78	10.42	66.5	6	13.0	9.31	68.6
Afr. black	58	15.23	11.19	66.6	15	13.46	9.01	68.2
Amer. Negro	46	16.25	10.90	66.8	18	14.20	9.25	65.0
So. Mongol	20			66.9	4			(65.1)
So. Utah Indian	18	15.10	10.15	67.4	10	13.70	9.70	70.6
Pecos Indian	79	14.74	10.11	68.3	24	13.42	9.67	73.5
Melanesian	20			68.6	11			69.1
Melanesian	10	14.90	10.29	69.1	12	13.42	9.20	68.6
Lenape Indian	4	15.20	10.60	69.5	9	13.90	9.90	70.7
Pima and Pueblo	5	15.50	11.03	71.0	5	13.80	9.95	72.0
Negrillo	4	13.15	10.03	77.1	6	12.10	8.93	73.8

(Bass 2005: 121)

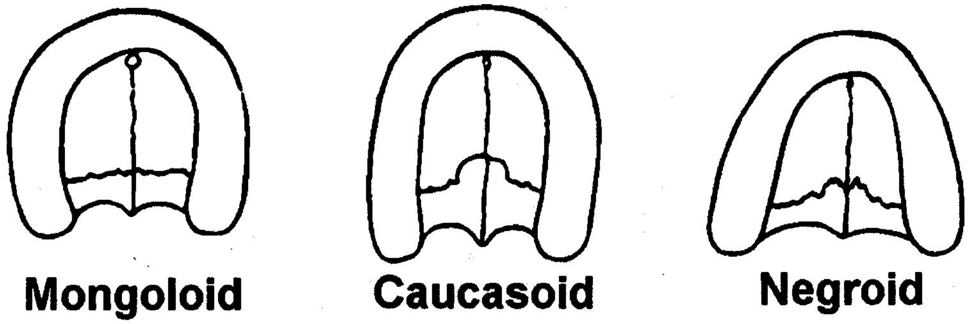
Asymmetry has plagued results throughout this case. Osteomyelitis could possibly be an indirect cause of the asymmetry. With the osteomyelitic infection and the sedentism that is assumed to be associated with the degree of infection would be expected to reduce skeletal mass. There is asymmetry from right to left in all the post-cranial measurements; the right side of the skeleton is longer and narrower when compared to the left. This is a good indicator that osteomyelitis is the precursor for the asymmetry because it is not localized to lower limb bones. Handedness or non-intentional skeletal deformation could be the cause of asymmetry and will be discussed later.

Ancestry from the Palate

Due to the extent of wear, damage, and postmortem loss of teeth, they will not be used for ancestry estimation. However, palate suture and gross dental morphology shapes can be used to estimate ancestry in this particular case. Zygomaxillary suture shape is included in this section because the close proximity of the zygomaxillary suture to the palate and maxillary dentition.

The palate shape is most similar to that of individuals with Native American ancestry. The flaring that commonly is seen in Africa ancestry in the palate shape is a result of the third molars not being present. This can be seen when compared to the dental arcade examples in Figure 2.1. In this figure the obsolete term Mongoloids are analogous to Native Americans, because the original study by Gill used Native Americans as the representative group for Mongoloids.

Figure 2.1 Ancestry from Palate Shape and Palatine Suture

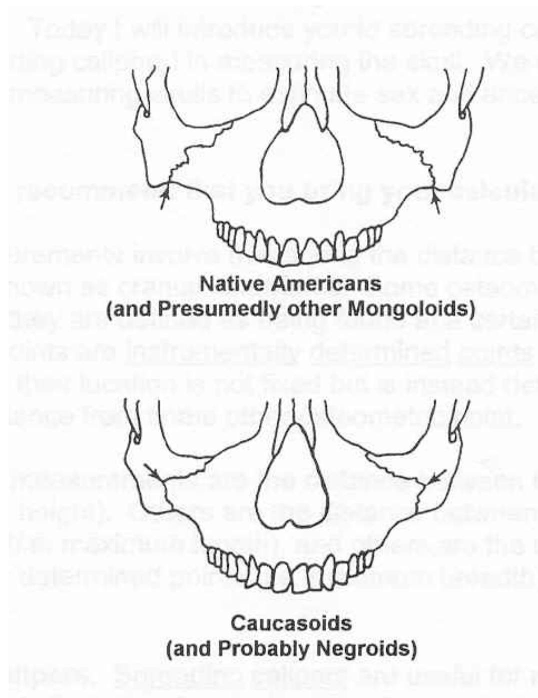


(Skelton 2002: 24)

Palate shape and palate suture shape for UMFC #66 is most similar to the characteristics of individuals of Native American ancestry. Lack of similarity for palate shape and suture shape argues against peoples of Africa or peoples of Europe.

Zygomaxillary suture shape is a good indicator of ancestry when combined with the methods mentioned previously. Zygomatic suture characteristics can be seen in Figure 2.2. This method places the structure of Native American suture shape as intermediate between the peoples of Africa and the peoples of Europe. The suture diverts laterally, which is seen in Native American populations. The suture structure for peoples of Europe inverts medially with the most lateral portion superior to the inferior zygomatic border.

Figure 2.2 Zygomaxillary Suture Characteristics



(Skelton 2002: 25)

Ancestry using FORDISC 3.0

FORDISC 3.0 is a forensic discriminate function program that attempts to estimate ancestry. Osteological measurements are used for estimation of ancestry. This statistical method of ancestry estimation uses a sample groups with known skeletal measurements for comparison to the individual being analyzed. Statistical probability that the individual being studied is from a particular population is only an indicator for ancestry and does not fully consider typical population variation. This method is only one tool in the forensic anthropology's myriad methods for ancestry estimation. Similar to any method presented in forensic analysis, FORDISC 3.0 is not a definitive assessment of ancestry and should only be used in conjunction with other methods.

Results from FORDISC 3.0 have only minor implications on estimation of ancestry because of the specificity of the discriminate function analysis, and the small and narrow sample comparison. This discriminate function program has two data sets to use for skeletal analysis. One is a data set using the osteometerics of only 12 different sample groups. The second data set is an even more specific set of 57 small and specific sample groups.

As seen in Table 2.5, JM (Japanese male) is the category this individual falls into with the basic FORDISC 3.0 sample group. The posterior probability of 0.438 can then transition in more broad terms that the individual has characteristics similar to, but not exactly like, this Asian descent group. Given that other methods that lump Asians and Native Americans into one group, sometimes called "Mongoloid", (once again the second highest probability is African descent). This FORDISC 3.0 and natural variation can show that this individual is of Native American descent.

Using Howell's data set provided by FORDISC 3.0 Peruvian Male or "PERM" is the result. Howell's small, specific sample groups do not adequately account for population variation and is likely the reason for misclassification using this discriminate function program. The strict framework of statistical discriminate function analysis does not take the place of visual assessment even with a statistically high typicality. Nonetheless, a Native American or Asian ancestry was once again given the highest probability.

Table 2.5 FORDISC 3.0 Results for UMFC #66

Group	Classified into	Distance from	Probabilities Posterior	Typ F	Typ Chi	Typ R
AF		11.0	0.313	0.998	0.856	0.680 (8/25)
AM		15.8	0.029	0.933	0.540	0.500 (18/36)
BF		23.6	0.001	0.403	0.130	0.093 (68/75)
BM		20.1	0.003	0.530	0.269	0.482 (44/85)
CHM		14.0	0.071	0.840	0.669	0.407 (48/81)
GTM		14.1	0.067	0.858	0.660	0.449 (38/69)
HM		16.9	0.017	0.811	0.464	0.585 (22/53)
JF		14.3	0.061	0.797	0.647	0.584 (42/101)
JM	**JM**	10.3	0.438	0.944	0.889	0.861 (14/101)
VM		24.1	0.000	0.563	0.116	0.102 (44/49)
WF		26.8	0.000	0.164	0.060	0.084 (120/131)
WM		23.6	0.001	0.231	0.131	0.240 (133/175)

Current Case is closest to JMs

Group	Classified into	Distance from	Probabilities Posterior	Typ F	Typ Chi	Typ R
AINF		20.8	0.005	0.900	0.346	0.256 (29/39)
AINM		25.9	0.000	0.665	0.133	0.041 (47/49)
ANDF		34.9	0.000	0.644	0.014	0.000 (36/36)
ANDM		23.4	0.001	0.883	0.219	0.083 (33/36)
ANYM		25.3	0.001	0.755	0.151	0.186 (35/43)
ARIF		16.8	0.039	0.992	0.604	0.536 (13/28)
ARIM		18.4	0.018	0.918	0.499	0.349 (28/43)
ATAF		24.2	0.001	-----	0.190	0.053 (18/19)
ATAM		17.1	0.032	0.986	0.580	0.333 (20/30)
AUSF		33.9	0.000	0.404	0.019	0.000 (50/50)
AUSM		37.2	0.000	0.283	0.007	0.000 (53/53)
BERF		23.1	0.002	0.714	0.235	0.241 (41/54)
BERM		21.5	0.004	0.746	0.308	0.333 (38/57)
BF20		25.9	0.000	0.445	0.132	0.385 (48/78)
BM20		26.7	0.000	0.330	0.111	0.515 (49/101)
BURF		28.1	0.000	0.524	0.081	0.218 (43/55)
BURM		32.9	0.000	0.362	0.025	0.018 (55/56)
BUSF		47.6	0.000	0.143	0.000	0.000 (50/50)
BUSM		44.7	0.000	0.297	0.001	0.000 (42/42)
DOGF		35.5	0.000	0.324	0.012	0.000 (53/53)
DOGM		29.1	0.000	0.574	0.064	0.063 (45/48)
EASF		24.2	0.001	0.844	0.187	0.079 (35/38)
EASM		27.9	0.000	0.588	0.086	0.020 (49/50)
EGYF		29.3	0.000	0.494	0.061	0.000 (54/54)
EGYM		24.9	0.001	0.606	0.164	0.102 (53/59)
GTM20		19.4	0.010	0.741	0.430	0.440 (42/75)
GUAF		17.5	0.027	0.990	0.558	0.214 (22/28)
GUAM		21.5	0.004	0.955	0.309	0.129 (27/31)
HAIF		24.7	0.001	0.823	0.172	0.154 (33/39)
HAIM		21.3	0.004	0.834	0.323	0.283 (33/46)
MOKF		23.7	0.001	0.728	0.209	0.000 (50/50)
MOKM		21.4	0.004	0.784	0.314	0.250 (39/52)
MORF		14.2	0.140	0.957	0.771	0.308 (36/52)
MORM		19.0	0.013	0.828	0.459	0.259 (43/58)
NJAF		24.2	0.001	0.906	0.188	0.091 (30/33)
NJAM		19.3	0.011	0.827	0.437	0.375 (35/56)
NORF		21.4	0.004	0.758	0.317	0.125 (49/56)
NORM		17.2	0.031	0.886	0.573	0.554 (25/56)
PERF		16.8	0.039	0.898	0.606	0.393 (34/56)
PERM	**PERM**	11.7	0.492	0.981	0.898	0.786 (12/56)
PHIM		21.5	0.004	0.789	0.310	0.235 (39/51)
SANF		18.1	0.020	0.881	0.519	0.173 (43/52)
SANM		15.6	0.070	0.935	0.685	0.500 (26/52)

SJAF	21.1	0.004	0.870	0.331	0.024 (41/42)
SJAM	19.5	0.010	0.848	0.424	0.392 (31/51)
TASF	37.9	0.000	0.416	0.006	0.000 (43/43)
TASM	34.1	0.000	0.457	0.018	0.130 (40/46)
TEIF	26.9	0.000	0.608	0.106	0.098 (46/51)
TEIM	24.6	0.001	0.889	0.175	0.265 (25/34)
TOLF	29.1	0.000	0.491	0.064	0.000 (55/55)
TOLM	33.3	0.000	0.340	0.022	0.000 (57/57)
WF20	33.5	0.000	0.081	0.021	0.125 (133/152)
WM20	33.2	0.000	0.060	0.023	0.212 (175/222)
ZALF	23.6	0.001	0.769	0.211	0.130 (40/46)
ZALM	22.0	0.003	0.749	0.283	0.222 (42/54)
ZULF	36.9	0.000	0.370	0.008	0.000 (47/47)
ZULM	32.7	0.000	0.368	0.026	0.071 (52/56)

Current Case is closest to PERMs

Ancestry Conclusion

The goal of ancestry estimation is to identify an individual's ancestral heritage in hopes of identifying the individual. Moreover, mixed results should not be discounted, because persons can have mixed characteristics without having mixed ancestry simply due to variation, or because mixed ancestry could very well be the answer. From methods used, one distinct ancestral lineage should be found. Each method attempts to refute or confirm previous method's results. Through the use of many methods, a definitive answer is made.

Similar to multifactor age estimation, ancestry benefits from several different methods for correct estimation of ancestry. It can be deduced from multiple methods that UMFC #66 is most likely of American Indian ancestry. Native American and Asian traits and are seen, and to a much lesser degree African traits exist. Traits of the peoples of Europe are not found, so European descent is ruled out.

Pathology and Trauma

Two pathological conditions are expressed on the skeletal material of UMFC #66. Most evident is osteomyelitis; the other is non-intentional skeletal deformation. Skeletal deformation results from low-grade trauma over an extended period of time (Ortner and Putschar, 1985), the same kind of abnormality seen in cranial deformation. The two conditions seen are not independent; osteomyelitis caused sedentism or lying on one side, in turn causing deformation of the ribs. Osteomyelitis is the possible precursor to skeletal deformation and will be discussed first. There are what appear to be fractures on a few ribs with no evidence of bone deposition from healing associating these ribs with skeletal deformation. No other pathologies or trauma are seen on the remains. For an expanded catalog of the bones associated with osteomyelitis and skeletal deformation, please see the skeletal inventory section in Appendix 3.

Osteomyelitis

Pathology seen throughout much of the skeletal elements is the result of an infection called osteomyelitis. Osteomyelitis results from the introduction of pyogenic bacteria into bone (Ortner and Putschar, 1985). This infection is typically localized to one bone or area of the skeleton. As described by Ortner and Putschar (1985), there are several routes for the bacteria to reach the skeleton. Most likely is the transfer of bacteria through wounds. Other possibilities are the direct introduction of the bacteria through adjacent soft tissue infections, or infection from a remote septic focus. The last two methods also have a wound of some sort as the precursor for an osteomyelitic infection, linking the pathology to a trauma.

Typically wounds that are survived occur on the limb bones, rather than the thorax, abdomen, or cranium, making osteomyelitis more common in limb bones. Individuals that contract osteomyelitis from a penetrating wound to the trunk or cranium will more likely die from the injury than the infection. No evidence of the infection will be seen in this scenario.

Osteomyelitis can be recurring, and initially show up in children and adolescents. Typically, individuals that are infected as subadults will go through bouts of the infection throughout life. This is the recurrent form of osteomyelitis. Adult osteomyelitis is typically localized since the periosteum on the long bones of adults inhibits the spread of infection. Periosteum of a subadult is loose to facilitate growing, and results in a widespread osteomyelitis infection. Individual UMFC #66 expresses the pervasive form of osteomyelitis since it is not localized. This suggests that the infection occurred earlier in life accounting for the amount of skeletal destruction.

UMFC #66 exhibits osteomyelitis in the lower left portion of the skeleton focusing on the left femur and left os coxa. The only recognizable landmark on the left femur is a condyle; the rest of the bone has been remolded, which indicates a response to provide some structural integrity for the bone called scaffolding. Tertiary osteomyelitis is the advancement of infection through cortical bone into the medullary cavity which is clearly expressed in the femur.

The left os coxa has indications of advanced osteomyelitis. Cortical bone has been remodeled and thickening of the ilium are characteristics of osteomyelitis. The acetabulum shows remodeling and deformation. Scaffolding has removed the femoral head, leaving no articulating surface for the acetabulum. Osteomyelitis has caused deformation of bones adjacent to the femur. This shows that the femur was the locus of infection. Evidence of infection is seen on bones from the lumbar vertebrae to the calcaneus.

This is a very typical case of osteomyelitis. Drainage cloacae are on what was the femoral shaft, suggesting tertiary osteomyelitis. These holes ease the transfer of fluid from the medullary cavity to the surface of the skin. The bone is very light in weight, with a thin cortex. Abscesses on adjacent bones show the septic hematogeneous infection. No other pathological condition is seen on the remains of UMFC #66.

Deformation

The ribs of this individual show reduced curvature. Osteomyelitis is the precursor of this trauma, not the direct cause of deformation. Ribs 3 through 12 on the right side show a flat area, a direct result of slight intermittent pressure over a long time. Such a deformation is from lying on the right side of the body. This deformation is a good indicator osteomyelitis had taken its course over many years, perhaps as early as childhood. Ortner and Putschar (1985) discuss deformation relating to feet and crania, not ribs, but the description of the mechanics for deformation provides a justifiable platform to state this is skeletal deformation.

Sex

It could be considered that sex estimation is one of the simplest determinations for a forensic anthropologist because there are only two possible choices. However, a problem inherent with sex estimation is the rarity with which individuals exhibit all-male or all-female traits. Most individuals exhibit some mixture of characteristics. Another problem is visual sex estimation methods cause the examiner to look for particular landmarks that are either male or female, not taking the entirety of the skeletal characteristics into account.

Sex from measurements of the Sacrum, Sternum, Scapula, Clavicle, Humerus, and Femur

Sex estimation from measurement of the sternum is a method that was attempted for this case. This method is only 80% accurate for males, and uses the sternal body length with the manubrium length. Stewart and McCormick (1983) state there is no measurement falling below 121mm, with males having shorter sternums. The maximum measurement (for females) is 173. The overlap range for males and females is 143 to 157mm. This individual measures 148mm, putting UMFC #66 in the overlap range and no sex estimation can be made.

Sex estimation from the scapula utilizes an index method. This index is derived from the maximum breadth multiplied by 100 and divided by the maximum length (Bass 2005: 117). The scapular index for the right is 56.3 and the left is 62.5. For the purpose of this sex estimation technique the left scapular index was used, which is at the bottom of all the male index ranges, within the ranges of all male and female groups, and closest to the mean of the Alaskan Eskimo male, as seen below in Table 3.1.

Table 3.1 Sex Estimation from Scapular Indices

Scapular Dimensions and Indices: Ranges of Variation[a]

	Sample total	Height total	Height, infraspinous	Breadth (Broca's)	Indices scapular total	Infra-spinous
Male						
All whites	1200	13.7–19.0[b]	9.8–14.7	8.6–12.4	53.8–85.4	68.1–111.1
		16.04[c]	12.08	10.49	65.0	86.9
		32.8[d]	40.6	36.2	48.6	49.5
North American Indian	229	13.0–18.4	9.9–14.8	8.9–12.0	57.3–75.9	66.2–101.3
		15.36	11.69	10.115	65.86	86.52
		32.2	41.9	30.6	28.2	40.6
Alaskan Eskimo	239	13.1–18.4	10.0–15.0	8.7–12.2	54.2–72.5	67.4–94.6
		16.22	12.77	10.12	62.4	79.2
		32.7	39.2	34.6	27.7	34.3
American Negro	126	14.1–18.7	9.9–14.3	9.0–12.4	58.9–76.9	76.8–111.1
		15.98	11.66	10.66	66.7	91.4
		28.8	36.9	31.9	27.0	37.5
Female						
All whites	457	11.7–16.8	8.5–13.0	8.1–11.3	55.6–84.7	71.4–116.7
		14.19	10.67	9.39	66.3	88.1
		35.9	42.2	34.1	43.9	51.4
North American Indian	179	11.4–16.4	8.4–13.0	8.3–10.9	58.4–86.8	72.3–114.3
		13.73	10.535	9.615	70.0	91.245
		36.4	43.7	27.0	40.6	46.0
Alaskan Eskimo	197	12.3–17.1	9.2–14.2	8.0–10.3	56.7–76.6	65.0–98.0
		14.10	11.06	9.25	65.6	83.6
		34.0	45.2	24.9	30.3	39.5
American Negro	46	12.6–16.1	8.8–12.4	8.7–10.6	57.7–76.3	75.6–112.8
		14.17	10.23	9.51	67.2	93.0
		24.7	35.2	20.0	27.7	40.0

(Bass 2005: 122)

Sex estimation from measurements of the clavicle varies in degree of accuracy, as Bass (2005) states about this method. Both clavicles measure 157 mm, which is within one standard deviation of the typical male mean. The male mean is 158.24 mm with a standard deviation of 10.06 mm, and the female mean is 140.28mm with a standard deviation of 7.99 mm. This shows that the individual is closer to the male mean than the female mean. This suggests that UMFC #66 is a male.

Sex estimation from measurements of the humerus is one of the best methods for sex estimation (Bass, 2005). The amount metric measure difference between the left and right humerus poses the problem of one side falling in the male range and the other side falling in the female. Transverse and vertical head diameters were also used. Transverse diameter of the right humerus head is 40mm, the left 46mm. The right is closer to the female range, with a mean of 36.98, and the left closer to male, with a mean of 44.66mm. This method yielded no usable results for sex estimation. The vertical head diameter of the right humerus is 44mm. The mean for males is 48.76mm and for female 42.67 mm, showing indeterminate sex estimation from the right humerus. The vertical diameter of the left is 45mm, with the same means as above, again indicating an indeterminate sex estimation result.

The length of the glenoid cavity of the scapula is 37 for both the left and the right. With the range for the male glenoid cavity being 37 or greater, it is at the bottom of the range, yielding no useable results for sex estimation

Sex estimation from the femur was only done using the right femur because of the osteomyelitis infection of the left femur. This method uses the maximum diameter of the femoral head. This measurement is 43mm. According to Bass (2005) the female range is 41.5 to 43.5, the intermediate range is 43.5 to 44.5mm, and the range for males is 44.5 and above. Because other postcranial components of the skeleton are more gracile on the right, this is likely the reason for the discrepancy of this method from others presented.

Sex estimation from the shape of the sacrum is a method that requires experience to be used properly. UMFC #66 has a sacrum that is flat, which is typical of females (Bass, 2005). This characteristic is influenced by the pathology affecting the os coxa.

The sacrum exhibits osteomyelitis on the left side, skewing the shape and causing asymmetry.

Sex estimation from the shape of the pelvis uses visual assessment and only the right os coxa was used, due to deformation of the left from osteomyelitis. The pelvic girdle is more vertical, which is a male characteristic. The greater sciatic notch is narrow, which is another male trait. Using Phenice's method, there is no ventral arc and no subpubic concavity - both male characteristics. The medial aspect of the ischiopubic ramus is intermediate and has been deformed by osteomyelitis. The pelvis exhibits more male characteristics than female, suggesting that this is a male.

Sex estimation for this particular case is more accurate using visual assessment of the skull and mandible. There are large supraorbital tori, which is a male trait. Borders of the orbits are rounded, not sharp, also a male characteristic. The zygomatic root extends past the auditory meatus, which is a male feature. The nuchal region is rugged, and the mastoid process is large and rugged. Both of these are male traits. The gonial angle is larger than 90 degrees, and the gonial region is flaring, which are both male qualities. The frontal bone is more flat and sloping to the posterior of the skull, which is a male trait. There is no frontal bossing, the presence of which is a female trait. The mandible, when viewed from the inferior aspect, is squarer, indicating male. Viewing the skull as a whole there is a rugged appearance, indicating that this is a male.

It is determined this individual is a male. This is based on the skull as the main method of sex estimation, with the other methods providing confirmation or at least neutral results.

Stature

Using derivations from the methods of Bass (2005), modifications can be made by averaging the stature estimates for several of the long bones. This allows for a better stature estimate. All long bones were used except bones that were affected by osteomyelitis or damage from post mortem handling; bones not used for stature estimation include: the left femur, the left and right tibia, and both fibula. These bones were either not present or were damaged from pathology. Weight will not be calculated simply due to the high amount of variability among individuals.

Table 4.1 Stature Estimation using formulas from Bass (1995)

Stature Estimation	Stature cm	Stature Inches	Stature Feet	Stature	St. Dev
White Male	169.58	66.76	5.56	5 ft 6.7 in	1.6
Negro Male	165.00	64.96	5.41	5 ft 4.9 in	1.7
Asian Male	166.25	65.45	5.45	5 ft 5. in	1.6
Mexican Male	165.90	65.31	5.44	5 ft 5.2 in	1.6
White Female	167.93	66.11	5.51	5 ft 6.1 in	1.5
Negro Female	161.64	63.64	5.30	5 ft 3. in	1.6
		Male Average	5.47	5 ft 5.6 in	
		Female Average	5.41	5 ft 4.9 in	

Table 4.1 shows that using this method when averaged for all males provide an average of 5 feet 5.6 inches making the conversion from centimeters to inches for the convenience of individuals not comfortable with metric measurements. The two ancestral affiliations that most closely relate to UMFC #66 is Asian male with a stature of

5 feet 5 inches with a standard deviation of 1.6 inches, and Mexican male of 5 feet 5.2 inches with a standard deviation of 1.6.

Skeletal Inventory

This is a mostly complete skeleton. Elements missing include various hand and foot bones, the hyoid, auditory ossicles, right tibia, right patella, and possibly two cervical and one thoracic vertebra. A detailed inventory of the skeletal material is in Appendix 3. The detailed inventory includes information on anomalous features and information on the sutures. Appendix 1 and 2 include a skeletal inventory of osteological measurements.

Time since Death

Time since death may be estimated only from the lack of soft tissue. The lack of soft tissue indicates that this individual has been deceased for no less than one year. Dental attrition can be used as an indicator of an extended time since death because the extent of occlusal wear is atypical for the present time period. There is no evidence for dental restoration, which indicates the individual died before the introduction of modern dentistry in the region. Finally, osteomyelitis is typically easily treated with antibiotics, and this pathology dates the individual to a period before the introduction of modern medicine to the area.

Conclusions

After employing several methods for skeletal analysis, conclusions can be made regarding age, sex, ancestry, stature, pathology and trauma.

Osteomyelitis present on the skeleton caused some methods to be of limited utility and therefore was not used in the calculation of age. However, using the methods presented, age estimation conclusions indicate that the individual was 36.3 to 53.2 years old at the time of death. With the most confidence placed on the results of cranial suture closure methods with an age of with a mean age of 52.5.

Ancestry estimation methods reveal that this person is probably of Native American descent. This is seen most clearly in cranial features. The amount of occlusal wear also resembles what is expected of Native American populations.

The two abnormalities seen on the skeletal material are interrelated. Osteomyelitis is seen throughout the lower portion of the skeleton with the focus of infection on the left femur. The left femur is unrecognizable, and abscesses are seen in adjacent bones. Deformation is seen on the ribs. This deformation is a result of slight or intermittent pressure over a long period of time. The ribs exhibit a flattening that would be a function of lying on the side for a long period of time due to pain associated with osteomyelitis.

The sex of this individual is determined through both visual and metric analyses. The os coxa was affected by osteomyelitis, causing metric analysis to be inconclusive. Visual as well as metric analyses of the cranium and os coxa are most consistent with the hypothesis that UMFC #66 is male. The application of stature methods presented in Bass

(2005) give a stature of 5 feet 5.6 inches. Weight was not calculated due to the high degree of variability.

A multifactoral and critical approach was taken and yielded conclusive results for age, ancestry, sex, stature, pathology and trauma. Considering the pathology alone, this case provides a textbook example of osteomyelitis that allows students to engage in research that without this case would be impossible using the University of Montana's collection. Further studies such as these, when combined with those of others, can yield more advanced methods of analyses that allow the forensic anthropologist to continue to fulfill their duty as the narrator for stories before untold.

Appendix 1

Cranial and Mandibular Measurements

Cranial Measurements

		Left	Right
Maximum Length	178		
Maximum Breadth	140		
Bizygomatic Breadth	137		
Basion-Beregma	131		
Base Length	100		
Basion Prosthion Length	95		
Maximum Alveolar Breadth	60		
Maximum Alveolar Length	46		
Biauricular Breadth	127		
Upper facial Height	66		
Minimum Frontal Breadth	89		
Upper Facial Breadth	106		
Nasal Height	50		
Nasal Breadth	25		
Orbital Breadth		38	39
Orbital Height		36	35
Biorbital Breadth	96		
Interorbital breadth	24		
Frontal Chord	103		
Parietal Chord	105		
Occipital Chord	98		
Foramen Magnum Length	33		
Foramen Magnum Breadth	27		
Mastoid Length		28	28

Mandibular Measurements

		Left	Right
Chin Height	30		
Body Height		30	28
Body Thickness		11	12
Bigonial Diameter	107		
Bicondular Breadth	123		
Minumum Ramus Breadth		39	38
Maximum Ramus Breadth		47	47

Appendix 2

Postcranial Measurements

		Left	Right
Clavicle			
Maximum Length		151	157
Sagittal Diameter at Midshaft		N/A	13
Vertical Diameter at Midshaft		N/A	10
Scapula			
Height		155	165
Breadth		97	93
Length of Spine		132	119
Supraspinious Line		47	55
Infraspinious Line		122	127
Glenoid Length		37	37
Scapular Index		62.5	56.3
Humerus			
Maximum Length		314	319
Epicondular Breadth		60	58
Maximum Vertical Diameter of Head		45	44
Maximum Diameter Midshaft		22	23
Minimum Diameter Midshaft		15	15
Least Circumference of Shaft		62	65
Transverse Diameter of Head		46	44
Vertical Diameter of Head		44	45
Robusticity Index		19.74	20.37
Radius			
Maximum Length		250	254
Sagittal Diameter Midshaft		16	16
Transverse Diameter Midshaft		12	11
Ulna			
Maximum Length		275	275
Dorso-Volar Diameter		17	14
Transverse Diameter		13	12
Physiological Length		241	241
Minimum Circumference		32	39
Caliber Index		16.18	13.27
Sacrum			
Anterior Height	109		
Anterior Surface Breadth	46		
Maximum Breadth (S-1)	109		
Sacral Index	100		
Innominate			

Height	N/A	193
Illiac Breadth	N/A	130
Pubis Length	N/A	79
Ischium Length	N/A	75
Ischio-Pubic Index	N/A	105.3
Femur		
Maximum Length	N/A	416
Bicondular Length	N/A	410
Epicondular Breadth	N/A	73
Maximum Diameter of Head	N/A	43
Anterior Posterior Subtrochanter Diameter	N/A	27
Transverse Subtrochanter Diameter	N/A	20
Anterior Posterior Diameter Midshaft	N/A	23
Transverse Diameter Midshaft	N/A	23
Circumference at Midshaft	N/A	71
Platymeric Index	N/A	135
Tibia		
Condylo-Malleolar Length	317	N/A
Maximum Proximal Epiphysis Breadth	N/A	N/A
Maximum Distal Epiphysis Breadth	N/A	N/A
Maximum Diameter at Nutrient Foramen	19	N/A
Circumference at Nutrient Foramen	18	N/A
	59	N/A
Fibula		
Maximum Length	309	N/A
Maximum Diameter Midshaft	32	N/A
Calcaneous		
Maximum Length	N/A	N/A
Middle breadth	N/A	N/A

Appendix 3

Detailed Skeletal Inventory

Cranial

- Frontal
    - Sutures
        - Left sphenofrontal suture is obliterated
            - With this, it is odd that the frontal zygomatic suture is open, being that they are in close proximity.
        - Coronal suture superior to the pterion is obliterated.
        - Coronal suture is not very complex.
        - The nasofrontal suture looks to have remnants of the meitopic suture.
    - Features
        - Slight porosity lateral to the sagital line, superior to the temporal line.
        - Depressed striation running anterior to posterior.
        - Left orbital border has secondary supraorbital foramen.
        - Flat spot on the superior portion of the left aspect of the parietal.
        - Accessory foramen superior to the supraorbital tori and the supraorbital foramen.
        - No porosity or abnormality in the orbits.
- Parietal Left
    - Sutures
        - Sphenoparietal suture is obliterated.
        - Coronal suture is obliterated from its junction to the sphenofrontal to the temporal line.
        - Sagital suture is mostly obliterated with areas that are commenced.
        - Lambdoidal suture is fairly complex, no ossicles present.
        - Paritalmastoid suture has one ossicle possibly more.
            - This suture has both obliterated and open areas and is very rugged.
    - Features
        - Slight depression inferior to the frontal line.
        - Posterier portion of the squamosal suture is obliterated and discolored, which is odd that it is not open, due to drying.
        - There are small pits, not porosity, on the posterior aspect of this bone. The pits are also on the adjoining bones, there is also discoloration.
- Parietal Left
    - Sutures
        - The sphenoparietal suture is commenced.

        - The coronal suture superior to the sphenoparietal is obliterated, with the remaining being commenced.
        - Lambdoidal suture is fairly complex, no ossicles are present.
        - Parietalmastoid suture is complex with ossicles.
        - Squamosal suture is not commenced, and open postmortem, as expected.
    - Features
        - Missing or obliterated parietal foramen.
        - Slight gray discoloration superior to the temporal line associated with the same on the other parietal.
        - Red discoloration and pitting in the area of parietal bossing similar to what is seen on the other parietal in the sphenomastoid area.
- Temporal Left
    - Sutures
        - Squamosal is mostly obliterated.
        - Temporal occipital suture is fairly open.
        - Sphenotemporal suture is partly open, with less opening the more superior.
        - Zygomaticotemporal suture is very open, likely due to preparing or drying.
    - Features
        - Mastoid process is rugged and robust, indicating that UMFC #66 is likely male.
        - There is some porosity posterior to the auditory meatus.
        - The suprameatal crest continues past the auditory meatus indicating that UMFC #66 is likely male.
        - The mandibular fossa looks normal, despite the amount of tooth wear.
        - Part of the styloid process is missing.
- Temporal Right
    - Sutures
        - Squamosal suture partly open, not necessarily due to drying, most likely not fused at time of death.
        - Temporo-occipital is fairly open with no ossicles. This is more open than expected, which is possibly due to drying or processing.
        - Sphenotemporal is very faint. Only a hairline suture is present.
        - Zygomaticotemporal is completely open and out of place. This is likely due to drying, preparation (defleshing), or mishandling the cranium.
    - Features
        - Oil clay residue remains from facial reconstruction.

        - Discoloration superior to the zygomatic process. This could be associated to the discoloration on the parietals.
        - The mastoid process is rugged and robust, indicating that this is likely a male.
        - The mastoid fossa looks normal and healthy despite the amount of wear on the teeth.
        - The styloid process is partially broken.

        Auditory Ossicles are missing in both left and right temporal bones.

- Occipital
    - Sutures
        - See parietals and temporals for information.
        - Basilar suture is completely fused.
    - Features
        - External occipital protuberance is fairly large and rugged with three accessory foramens.
        - Superior and inferior nuchal lines are rugged and have striations from muscle attachments, making this case appear possibly male.
        - Inferior to the inferior nuchal lines are three accessory foramen.
        - Anterior to the foramen magnum in the basilar portion, is an accessory foramen.
- Maxillae (Left and Right)
    - Sutures
        - Zygomaticomaxillary suture is similar in appearance to what one might see in Peoples of European Descents or Peoples of Africa. But, this also could be considered intermediate between both meaning Asians and Peoples of European Descent.
        - Maxillary suture is mostly closed with a pronounced nasal spine.
        - The palate shape resembles one Asian ancestry.
        - The palatine suture is similar to that of Asians ancestry.
        - No presence of nasal sill, but slight “guttering.”
        - Sphenomaxillary suture is not completely fused.
    - Features
        - Green oil-based clay residue on the alveolar region and between the teeth.
        - Zygomaxillary suture is slightly open, which can be expected from the drying process.
        - Possible abscess between P^1 and P^2.
        - Excessive wear to makes determination of race by cusp patterns impossible.
- Zygomatic-Right
    - Sutures
        - Zygomaticotemporal suture is open and displaced, likely due to drying process. There are no apparent signs of pathology or trauma associated with the displacement.

        - Zygomaticofrontal suture is slightly open with particular regard to the orbital border.
    - Features
        - Slight porosity on the right zygomatic.
        - Rugosity from muscle attachments on the inferior border of the Zygomatic.
- Zygomatic-Left
    - Sutures
        - Zygomaticotemporal suture is open and slightly displaced, which is likely due to the drying process. There appears to be no signs of pathology or trauma associated with displacement.
    - Features
        - Slight porosity to the left zygomatic.
        - Rugosity apparent with the muscle attachments on the inferior border of the Zygomatic associated with mastication.
- Nasal-Left and Right
    - Sutures
        - Nasofrontal is not completely fused, with particular regard to the suture superior of the right nasal bone.
        - The nasal suture is slightly open.
        - On the nasomaxillary suture, the right side is more open than the left.
    - Features
        - A triangular defect on the left inferior border is present.
        - The superior border of the nasal bone encroaches on the inferior border of the frontal bone.
- Sphenoid
    - Sutures
        - The sphenotemporal suture is slightly open on the left, likely due to the drying process. No anomalies are present. The right sphenotemporal suture has commenced to partial obliteration. It is slightly open medial of the zygomatic process.
        - Sphenofrontal-see frontal bone
        - The basal suture is completely obliterated
        - Sphenoparietal-see parietal bone
        - Sphenomaxillary-see maxilla
        - The right side of the vomer is open. The left side is a slightly closed articular area.
    - Features
        - There is asymmetry in the lesser wing of the sphenoid. The left lesser wing has a more medial angle and greater appearance of surface area.
        - Remnants of what appear to be plant roots are present in the area between the sphenoid and the maxilla.
- Ethmoid
    - Sutures

        - Nothing anomalous.
    - Features
        - Nothing anomalous.
- Vomer
    - Sutures
        - Nothing anomalous.
    - Features
        - Posterior deviation to the left is present (protruding to the left).
- Hyoid
    - Not Present
- Lacrimal
    - Sutures
        - Nothing noted.
    - Features
        - Both sides exhibit handling wear in the suture between the ethmoid and the lacrimal bone.
        - No other anomalous features.
- Palatine
    - Sutures
        - For suture shape, see maxilla.
        - Suture is slightly open, possibly from the drying process.
        - No other anomalous features.
    - Features
        - Nothing anomalous.
- Mandible
    - Sutures
        - Mandibular symphysis is completely fused and obliterated.
    - Features
        - The angle of the ascending ramus is greater than 90 degrees, indicating that this is a male.
        - Gonial flaring and rogosity also indicates male characteristics.
        - The chin is more square indicating male.
        - The ascending ramus is wide, which is also indicative of male traits.
        - Teeth-see dentition.

Post Cranial

- Cervical Vertebrae
    - Missing two.
        - Atlas
            - The transverse process and the superior articular pit are asymmetrical. There is general asymmetry throughout.
        - Axis
            - The axis is fragmentary, likely due to box or coffin wear.
            - No anomalous features.
        - 3rd Cervical Vertebrae
            - There is wear on the spinous process.

        - Osteroarthritis is present on the superior and inferior portion of the body.
    - 4th Cervical Vertebrae
        - There is a similar condition to the 3rd Vertebrae.
    - 6th Cervical Vertebrae
        - It is assumed that this is the 6th vertebrae because it does not fit together with the 1st thoracic vertebrae. This also could be the 7th cervical vertebrae with the 5th and 6th missing. Also, the 1st thoracic vertebrae may be missing.
        - Osteoarthritis is evident on the articular surface both superiorly and inferiorly on the body. Slight porosity is also seen.
        - The age, from osteophytosis, would be inconclusive due to osteomyelitis and artificial articulation.
- Thoracic Vertebrae-*missing one.*
    - The area is artificially articulated with epoxy and green modeling clay.
    - There is slight wear on the transverse process.
    - There is lipping and porosity on the superior and inferior portion of the body. (Only four surfaces of the body are viewable).
    - There is considerably more porosity on the left side of the body than on the right. This could be a continuation of the osteomyelitic infection.
- Lumbar Vertebrae
    - The lumbar vertebra are very porous which is associated with the osteomyelitic infection. Degeneration is concentrated to the body of the vertebrae.
    - There is extensive wear on the transverse process. This wear is a function of both osteomyelitis weakening the structure and box wear.
    - There is incomplete fusion of the body of L4 and L5 vertebrae.
    - Porosity is present on the articular surfaces of the body of the Lumbar vertebrae which appears to be caused by the spreading of osteomyelitis and due to a lack of a border lipping it is not from physical degeneration, physical labor or osteoarthritis associated therein.
- Sacrum
    - There is incomplete fusion of the neural arch, which is possibly associated with Spina Bifida.
        - Spina Bifida is a common abnormality mentioned in archeology (Ortner, 1985).
    - Porosity and asymmetry is present, associated with the osteomyelitic infection of the left femur.
        - Porosity and deformation are more evident on the left portion of the sacrum, being most evident on the sacral side of the auricular surface.
    - There is slight lipping on the promontory and the porosity is associated.
    - Fusion of the 1st coxalgial vertebrae is present.
    - Sacral shape is “flat,” which is typical of female characteristics, but deformed from osteomyelitis.

    - Max Anterior Breadth=109
    - Max Anterior Height=109
    - Sacral Index=100
- Coccyx
    - Only one present and fused to the sacrum.
    - No anomalous features.
- Sternum
    - Manubrium
        - The left portion of the jugular notch has a superiorly projecting atypical process.
        - Rugosity is associated with the right 1st Costal notch.
        - Exhibits generalized porosity and is asymmetrical.
    - Body
        - Has general porosity and is asymmetrical.
        - No other significant features.
    - No xyphoid present.
- Scapula
    - Left
        - The medial border has a depression.
        - Glenoid cavity presents lipping with no real extensive evidence of osteoarthritis.
        - There are cracks in the body that are associated with drying and handling.
    - Right
        - Coracoid and acromion process exhibit wearing from handling.
        - There are cracks in the body associated with drying and handling.
        - Glenoid cavity does not exhibit osteoarthritis.
- Clavicle
    - Left
        - Postmortem deformation midshaft that is possibly associated with recovery.
    - Right
        - Nothing notable.
    - Both
        - Exhibit slight porosity.
- Ribs
    - Left
        - 1st
            - Sternal end is lipped and has slight macroporosity.
        - 2nd
            - Sternal end absent
        - 3rd
            - Nothing notable.
        - 4th
            - Sternal end absent.
        - 5th

        - Deformation from handling proximal to the sternal end.
    - 6th
        - Sternal end missing.
    - 7th
        - Root etching in costal sulcus.
    - 8th
        - Medial end exhibits handling wear.
    - 9th
        - No abnormalities noted.
    - 10th
        - No anomalies noted.
    - 11th
        - Articular surface is missing.
    - 12th
        - Dorsal and ventral ends missing.
- Right
    - 1st
        - Sternal End rugged and porous.
    - 2nd
        - Sternal End and Head show handling wear.
    - 3rd
        - No anomalies noted.
    - 4th
        - Sternal end missing.
    - 5th
        - Nothing noted.
    - 6th
        - Nothing abnormal noted.
    - 7th
        - Depression on the sternal end of the body.
    - 8th
        - Nothing noted.
    - 9th
        - Possible fracture proximal to the medial end (postmortem).
    - 10th
        - Two possible postmortem fractures, or deformation.
    - 11th
        - Two possible postmortem fractures, or deformation.
    - 12th
        - Nothing noted.
            - Previous fractures could be deformation due to burial.
- Ribs 3-12 on both the left and right side all have deformation related to curvature. This is a deformation of the bone structure over a long period of time. The rib curvature deformation on the left is associated with the osteomyelitis, not directly related to the infection, related to lying on the

left side of the body for a long period of time due to a lack of mobility. The right ribs show inverse deformation, meaning that there is more than expected curvature in the rib shape. This appears to be unintentional, this is from intermittent pressure over a long period of time.

- Humerus-Left and Right
    - No fractures or anomalous features.
    - No evidence of osteomyelitis on the head, trochlea, or capitulum.
    - Rugged deltoid tuberosity.
        - Handedness could be expressed in that the right is slightly longer than the left.
        - There is handling wear on the head of the right humerus.
- Radius
    - Left
        - Handling wear is present on the head.
    - Right
        - Handling wear is apparent on the head.
    - Both
        - Exhibit a prominent interosseous crest.
- Ulna-Left and Right
    - No anomalous features.
- Os coxa
    - Left
        - Extensive deformation from osteomyelitis.
            - Ilium
                - Ilium has thickening or inflammation (postmortem) of the iliac crest, likely from handling.
                - Osteophyte development at the ilium/ischium border.
                - Deformation of the auricular surface.
                - Highly macroporosic.
            - Ischium
                - There is postmortem deformation on the ischial tuberosity.
                - Osteomyelitic deformation of acetabulum.
                - Gross deformation due to osteomyelitis.
            - Pubis
                - Osteophyte formation in the obturator foramen.
                - Obliteration of the pubic symphysis.
            - All encompassing deformation relates to terminal osteomyelitis.
    - Right
        - Ilium
            - Possible osteomyelitic deformation on the posterior portion of the iliac spine. It is thicker and significantly more porous.
        - Ischium

            - Slight porosity.
        - Pubis
            - Deformation of pubic symphysis from osteomyelitis.
- Femur
    - Left
        - Focus of the osteomyelitic infection. The only recognizable landmark is the posterior portion of the lateral condyle.
        - Significantly shorter and lighter than the right Femur.
    - Right
        - Striations on the greater trochanter and gluteal tuberosity.
        - Postmortem depression fracture of the medial epicondyle.
        - Slight lipping of the tibia articular surface associated with the intercondylar fossa border.
        - Porosity on proximal and distal ends.
        - Handling wear on ends.
- Tibia-Left Only
    - Degenerative deformation of the proximal end associated with osteomyelitic infectious destruction. A large portion of the articular surface superior to the tibial tuberosity is missing.
- Patella-Right Only
    - Wear of the cortical bone on the articular facet border.
- Tibia
    - Left
        - Proximal and distal ends show osteomyelitic degeneration.
    - Right
        - Significantly more rugged than the left
        - Slight porosity.
- Talus-Left Only
    - Porous, signifying osteomyelitic infection.
    - Dark discoloration.
- Calcaneus
    - Significant deformation of the calcaneal tuber
        - Depression looks to be associated with the foot sitting on the heel (calcaneal tuber) for an extended period of time.
    - Porosity throughout.

Bibliography

Bass, Williams M.
2005 *Human Osteology: A Laboratory and Field Manual*. Fifth Edition. Missouri Archaeological Society, Columbia, MO.

Buikstra, J.E. and D.H. Ubleaker
1994 *Standard for Data Collection from Human Skeletal Remains*. Arkansas Archaeological Survey, Fayetteville, Arkansas.

Burns, K.M.
1999 *Forensic Anthropology Training Manual*. Prentice hall, New Jersey.

Byers, Steven N.
2002 *Introduction to Forensic Anthropology: A Textbook.* Allyn and Bacon, Boston, MA.

DiBennardo, Robert and James V. Taylor
1979 Sex Assessment of the Femur: A Test of a New Method. *American Journal of Physical Anthropology* 50(4):635-638.

Giles, Eugene
1964 Sex Determination by Discriminate Function Analysis of the Mandible. *American Journal of Physical Anthropology* 22(2):129-136.

Giles, E. and O. Elliot
1962 Race Identification from Cranial Measurements. *Journal of Forensic Sciences* 7:147-57.

Graves, Joseph L. Jr
2004 *The Race Myth: Why we Pretend Race Exists in America*. Dutton, New York.

Howells, W.W.
1995 *Who's Who in Skulls: Ethnic Identification of Crania from Measurements*. Peabody Museum of Archaeology and Ethnology Harvard University, Massachusetts.

Hrdlicka, A.
1942 The Adult Scapula: Additional observations and measurements. *American Journal of Physical Anthropology* 29(3):363-415.

Iscan, M.Y., S.R. Loth, and R.K. Wright
1985 Age Estimation from the Rib by Phase Analysis: White Females. *Journal of Forensic Sciences* 30(3):853-63.

Krogman, Wilton Marion, and Iscan, M.Y
1986 The Human Skeleton in Forensic Medicine. Charles C Thomas. Springfield, Ill

Mann, R.W.

1993 A Method for Siding and Sequencing Human Ribs. *Journal of Forensic Sciences* 38:151-55.

Meindl, R.S. and Lovejoy, C.O.
1985 Ectocranial Suture Closure: A Revised Method for the Determination of Skeletal Age at Death Based on Lateral-Anterior Sutures. *American Journal of Physical Anthropology* 68:57-66

Ortner, Donald and W.G.J. Putschar
1985 *Identification of Pathological Conditions in Human Skeletal Remains*. Smithsonian Institution Press, Washington.

Ousley S.D. and R.L. Jantz
2006 *FORDISC 3.0: Personal Computer Forensic Discriminate Functions*. The University of Tennessee, Knoxville.

Parsons, F.G., and Box, C.R.
1905 The Relation of the Cranial Sutures to Age. *The Journal of the Anthropological Institute of Great Britain and Ireland* 35:30-38

Skelton, Randall R.
2006 Osteology Laboratory Manual. *Unpublished Laboratory Manual for ANTH 412.* The University of Montana - Missoula.

Suchey, Judy Myers, D.V. Wisely, R.F. Green and T.T. Noguchi
1979 Analysis of Dorsal Pitting in the Os Pubis in an Extensive Sample of Modern American Females. *American Journal of Physical Anthropology* 51:517-39.

Todd, Wingate T. and Lyon D.W. Jr
1924 Endocranial Suture Closure: Its Progress and Age Relationship *Part I. Adult Males of White Stock. The American Journal of Physical Anthropology* 7,3: 325-384

Todd, Wingate T. and Lyon D.W. Jr
1925 Cranial Suture Closure: Its Progress and Age Relationship *Part II. Ectocranial Closure in Adult Males of White Stock. The American Journal of Physical Anthropology* 8,1: 23-71

Trotter, M. and G.C. Gleser
1952 Estimation of Stature from Long Bones of American Whites and Negroes. *American Journal of Physical Anthropology* 10:463-514.

White, Tim D. and Peter Arend Folkens
2000 *Human Osteology*. Second Edition. Academic Press, San Diego.